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IWATA YOSHIAKI
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TAMURA IZUMI**(54) VIBRATION CONTROL DEVICE FOR
ELECTRICAL VISCOUS FLUID**

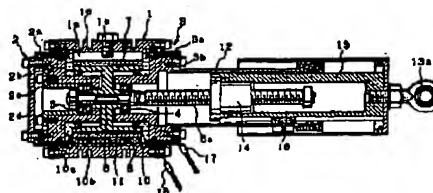
(57) Abstract:

PROBLEM TO BE SOLVED: To provide a large damping force using a relatively small device, and control a damping force over a wide range even at a high speed by forming the outer surface of a rotor fixed to a center shaft and the inner surface of a cylinder as electrode surfaces corresponding to each other.

SOLUTION: A member 2d of a lid body 2 and a pull handle 13a of a slider 13 are connected to a structure or equipment. When the slider 13 moves in a guide cylinder 12 in a contracting direction, due to exposure to the vibration of the structure or the like, a nut body 14 at the end of the slider 13 causes the reciprocating motion of a center shaft 6 held on lid bodies 2 and 3 via a screw shaft 6a and bearings 4 and 5, and a rotor 7 fixed to the center shaft 6. An electrical viscous fluid 10 is retained in a control gap 10b between the outer surface of the rotor 7 and the inner surface of a cylindrical body 1 via an oil seal 8, and the viscosity of the fluid 10 increases, when voltage is applied to the electrode surface of the control gap 10b, thereby applying braking torque for the reciprocating rotation of the rotor 7. In addition, the braking torque of the rotor 7 is converted into a

damping force along the axial direction of the slider 13 via the screw shaft 6 and the nut body 14. The vibration of the structure is thereby controlled.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the damping device of the building itself which therefore made the generating damping force adjustable at applied voltage, or the relative damping device between devices using an electroviscous fluid.

[0002]

[Description of the Prior Art] An electroviscous fluid is a fluid from which viscosity changes according to applied voltage, and a speed of response has the description with very little [early] power consumption. JP,6-2731,A is well-known as what used this for the vibration-deadening means. This makes an electroviscous fluid produce the flow of an one direction in a motion of a piston and an operation of a check valve using a cylinder like drawing 1 . It is what leads the flow to the clearance for control between the tubes by which concentric arrangement were carried out to the cylinder and the cylinder outside, makes the external surface of a cylinder, and the inside of a tube a corresponding electrode surface, and is used for the suspension system of a car. The applied voltage to an electrode surface is controlled according to vibration transmitted from a road surface, the fluid viscosity of the clearance for control is changed, and the damping force is adjusted.

[0003]

[Problem(s) to be Solved by the Invention] However, a chain will be empty slipping turned off if the thing using the above cylinders shows the strong dependency over a fluid rate, especially an electroviscous fluid is used, in order that an electroviscous fluid may flow the clearance for control at high pressure and a high speed, and it is high-speed. Moreover, when a damping force is enlarged, or spacing of the clearance for control is made small so that it can control also by the low battery, a flow passage area decreases, the unrelated diaphragm effectiveness is generated as applied voltage, and there is also fault that a damping force is broadly uncontrollable by applied voltage. In order to control a big damping force broadly, without changing spacing, it will be necessary to secure the area of the clearance for control widely, and equipment will be enlarged. It was originated in view of the above mentioned situation, and a damping force comparatively small [the purpose] and big is acquired, and even when this invention is high-speed, it is wide range and is to offer the electroviscous-fluid damping device which can control a damping force.

[0004]

[Means for Solving the Problem] Casing which fixes a lid to the both ends of a cylinder object, and changes in order to attain the above-mentioned purpose, it supports to the lid of cylinder object both ends through bearing -- having -- a round trip -- it fixing to a pivotable medial axis and a medial axis, and external surface with the body of revolution which the inside of a cylinder object was made to face at suitable spacing The oil seal prepared between a lid and body of revolution in the periphery section of bearing, The guide cylinder which fixed to one lid, and the screw shaft prepared in the extension of a medial axis, The slider inserted in the guide cylinder free [sliding], and a guide cylinder and the sliding key prepared between sliders, It fixed to the slider point, the fluid room filled up with the above-mentioned screw shaft, the nut object to screw, and the electroviscous fluid of the method space of the outside of bearing closed by oil seal was constituted, and the external surface of body of revolution and the inside of a cylinder object were made into the corresponding electrode surface.

[0005]

[Function] If the slider of this equipment moves in the flexible direction in response to vibration of the structure in the inside of a guide cylinder, both-way rotation of the body of revolution which the nut object at the tip of a slider which had rotation therefore restrained by the sliding key fixed to the screw shaft, the medial axis supported by the lid of casing both ends through bearing, and the medial axis will be carried out. Therefore, the electroviscous fluid is held in the clearance for control between the external surface of body of revolution, and the inside of a cylinder object at oil seal. If an electrical potential difference is impressed to the electrode surface of the clearance for control, the viscosity of an electroviscous fluid will rise and damping torque will be given to both-way rotation of body of revolution. Therefore the braking torque of body of revolution is changed into a screw shaft, a nut object, and a sliding key at the damping force of slider shaft orientations, and damps vibration of the structure.

[0006] For the resistance by the so-called shear flow which is produced by relative displacement with body of revolution and an electroviscous fluid at high pressure and a high speed unlike the cylinder which flows the clearance for control, the flow of the electroviscous fluid in this equipment has few rate dependencies of damping torque, and can demonstrate viscous effectiveness to a high-speed field. Although an electrode surface has spacing of about 1mm and the electrical potential difference of 0-several kV is impressed from an external power and a controller, current density is 0 - 10micro A/cm² of numbers. There is very little power consumption. The speed of responses of damping torque are Number mSec thru/or several 10 mSec(s), and even if they receive the random wave which various vibration overlapped, they can generate the optimal damping force in an instant according to dynamic behavior which changes every moment, such as vibration frequency, and a rate, acceleration. Although it generates in proportion to the outer diameter, die length, and applied voltage of body of revolution and damping torque acts on a medial axis, since the lead of the screw shaft prepared in the extension of a medial axis also serves as an element of damping-force increase and decrease, it can miniaturize equipment.

[0007]

[Embodiment of the Invention] A drawing is explained. The cylinder object 1 fixes lids 2 and 3 in the both-ends periphery section, and constitutes casing, a lid 2 unifies four member 2a and 2bs, and 2c and 2d, and the lid 3 is unifying two members 3a and 3b. Members 2a and 3a consist of insulating materials, such as engineering plastics, the cylinder object 1 and body of revolution 7 are insulated electrically, and the terminal 17 with which the conclusion bolt of member 3a and the cylinder object 1 was equipped at body of revolution 7 is enabling energization of the terminal 16 with which the conclusion bolt of member 3a and member 3b was equipped on the cylinder object 1.

[0008] The bore section of the above-mentioned member 2b and 3b is supporting the medial axis 6 through bearing 4 and 5 respectively. Therefore, the lubrication of the bearing 4 and 5 is carried out to grease etc. Body of revolution 7 fixed to the medial axis 6, and the periphery of body of revolution 7 separated clearance 10b for control of suitable spacing, and has faced it the inside of the cylinder object 1. However, this invention is not restrained no matter clearance 10b for control may be formed in what configuration. Clearance 10b for control of the taper-like circular ring which made the end the major diameter and made the other end the minor diameter has the merit which can adjust spacing of clearance 10b for control by relative shaft-orientations migration of the cylinder object 1 and body of revolution 7.

[0009] Oil seal 8 was formed in the periphery section of bearing 4 and 5 between lids 2 and 3 and body of revolution 7. Oil seal 8 fixes the outer-diameter section to the end-face crevice of body of revolution 7, slides the bore section with the heights of member 2b and 3b, and is carrying out the seal of the electroviscous fluid 10 of fluid room 10a. Oil seal 8 is supplied by the product made of rubber, and its seal nature is high. Since an electroviscous fluid 10 is not a lubricating oil, it has isolated bearing 4 and 5 and an electroviscous fluid 10 with oil seal 8. When the particle is distributed by the electroviscous fluid 10, destruction of the particle which depends on bearing 4 and 5, and damage on the bearing 4 and 5 by the particle can be prevented.

[0010] Moreover, oil seal 8 is also changeable into mechanical seal 9. Sliding child 9a of mechanical seal 9 is supported to revolve by the O ring 9c applied part of member 2b and 3b in the bore section, presses against the side face of body of revolution 7 the reaction force of spring 9b, and the internal

pressure of fluid room 10a which acts on sliding child 9a, and is carrying out the seal of the electroviscous fluid 10. If electric conduction material, such as a metal, is used for sliding child 9a and spring 9b, the energization function other than a seal function is added, and since an electrical circuit is formed without passing bearings 4 and 5, damage on the bearings 4 and 5 which depend on energization can be prevented. Furthermore, in order to reinforce the seal function of the mechanical seal 9 with an energization function, it is also possible to use together mechanical seal 9 and oil seal 8.

[0011] As for an electroviscous fluid 10, temperature and the volume change with ambient temperature and vibration-deadening operations. When a damping device absorbs the kinetic energy of the structure, the kinetic energy is changed into heat energy, and, in the case of this equipment, it is for the temperature of an electroviscous fluid to rise. Therefore, fluid room 10a and two or more through hole 1a open for free passage were prepared on the same radius line of the cylinder object 1, and the accumulator 11 which consists of the bellows-like metal bellows which attached what accumulated the rubber float, and a both-ends plate has been arranged. The volume change of an electroviscous fluid 10 is absorbed, an electroviscous fluid 10 is insufficient, a gas part occurs, control becomes impossible or an accumulator 11 prevents a pressure rising and starting an oil spillage etc. An electroviscous fluid 10 can be filled up from one of the through hole 1a which is not inserting an accumulator 11, and oil-supply-port 1b which was open for free passage.

[0012] When this equipment absorbs the kinetic energy of the structure continuously, the heat by which energy conversion was carried out is accumulated into equipment. If heat is accumulated, we will become an elevated temperature and, as for quality of the material degradation *****, will be anxious about the fall of a vibration-deadening function. Also although it is called a damping device, a certain cure is needed. This equipment formed heat sink 1c in the periphery outcrop of the cylinder object 1, and it considered it so that it might not become an elevated temperature, even if it absorbed the kinetic energy of the structure continuously.

[0013] The guide cylinder 12 which fixed to the lid 3 inserts a slider 13 free [sliding], and it has the sliding key 15 of rotation prevention between the guide cylinder 12 and a slider 13, and screw shaft 6a prepared in the extension of a medial axis 6 screws with the nut object 14 which fixed to slider 13 point, and constitutes the medial-axis round trip slewing gear. A ball screw with a usually sufficient transmission efficiency is used for screw shaft 6a and the nut object 14.

[0014] This equipment constituted as mentioned above connects with the structure or a device, and inviter 13a of 2d of members of a lid 2 and a slider 13 is used for it. If the slider 13 of this equipment moves in the flexible direction in response to vibration of the structure etc. in the inside of the guide cylinder 12, both-way rotation of the body of revolution 7 which the nut object 14 at slider 13 tip which had rotation therefore restrained by the sliding key fixed to screw shaft 6a, the medial axis 6 supported by the lids 2 and 3 of casing both ends through bearing 4 and 5, and the medial axis 6 will be carried out. Therefore, the electroviscous fluid 10 is held at clearance 10b for control between the external surface of body of revolution 7, and the inside of the cylinder object 1 at oil seal 8 or mechanical seal 9. If an electrical potential difference is impressed to the electrode surface of clearance 10b for control, the viscosity of an electroviscous fluid 10 will rise and damping torque will be given to both-way rotation of body of revolution 7. Therefore the braking torque of body of revolution 7 is changed into screw shaft 6a and the nut object 14 at the damping force of slider shaft orientations, and damps vibration of the structure.

[0015]

[Effect of the Invention] Unlike the oil hydraulic cylinder which flows the clearance for control at high pressure and a high speed, for a simple shear flow, the flow of the electroviscous fluid in this equipment has few rate dependencies of damping torque, and does not have the diaphragm effectiveness generated regardless of applied voltage. Therefore, viscous effectiveness can be demonstrated to a high-speed field, it is wide range and a big damping force can be controlled. Moreover, although it generated in proportion to the outer diameter, die length, and applied voltage of body of revolution and damping torque acted on the medial axis, since the lead of the screw shaft prepared in the extension of a medial axis also served as an element of damping-force increase and decrease, the miniaturization of equipment of it was attained.

[0016] If electric conduction material, such as a metal, is used for the sliding child and spring of

mechanical seal, the energization function other than a seal function is added, and since an electrical circuit is formed without energizing bearing, damage on the bearing which depends on energization can be prevented.

[0017] Since the accumulator has been arranged in the fluid room, the volume of the electroviscous fluid from which an accumulator changes with ambient temperature and vibration-deadening operations is absorbed, an electroviscous fluid is insufficient, and a gas part occurs, and control becomes impossible or it can prevent a pressure rising and starting an oil spillage etc.

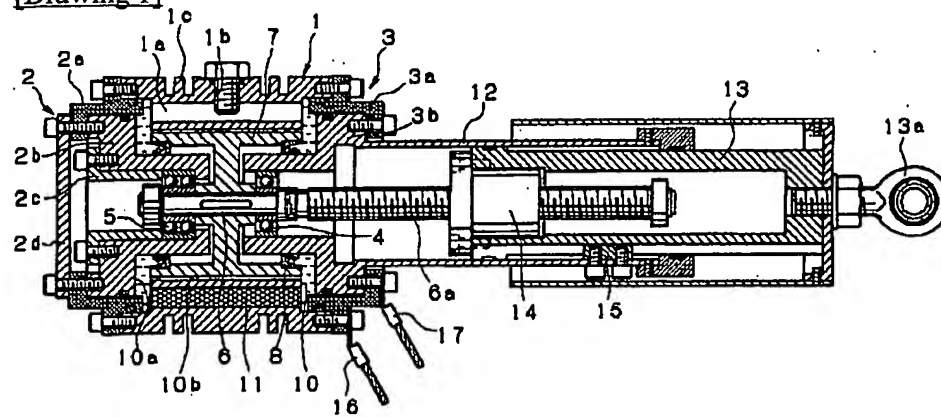
[0018] Since the heat sink was formed in the periphery outcrop of a cylinder object, the heat accumulated by absorbing the kinetic energy of the structure is emitted, and the fall of quality-of-the-material-degradation or a vibration-deadening function can be prevented.

[0019] Although an electrode surface has spacing of about 1mm and the electrical potential difference of 0-several kV is impressed from an external power and a controller, current density is 0 - 10micro A/cm² of numbers. There is very little power consumption. The speed of responses of damping torque are Number mSec thru/or several 10 mSec(s), and even if they receive the random wave which various vibration overlapped, they can generate the optimal damping force in an instant according to dynamic behavior which changes every moment, such as vibration frequency, and a rate, acceleration.

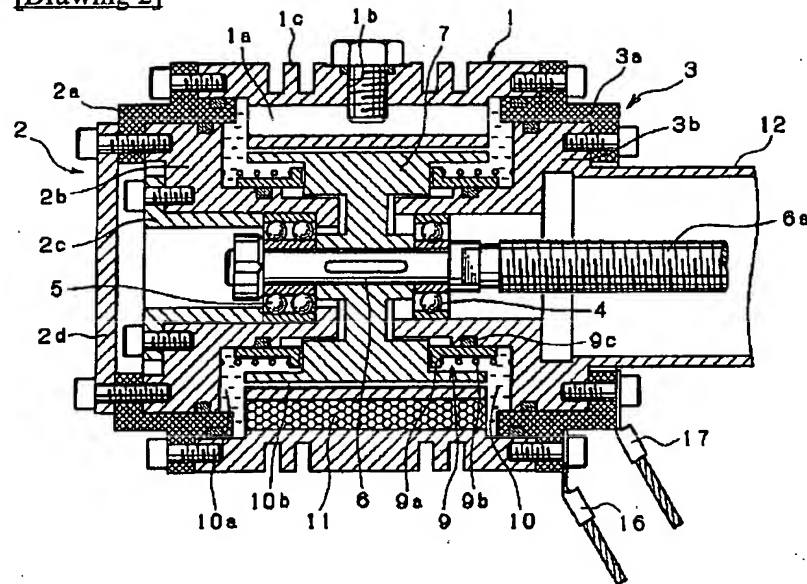
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DRAWINGS

[Drawing 1]



[Drawing 2]



[Drawing 3]

